Subsurface Microsensors for Assisted Recertification of Thermal Protection Systems

Frank S. Milos

Integrated Vehicle Health Management (IVHM) is recognized as a critical technology for reducing costs and increasing the safety and reliability of access to space. Ames is the lead Center for development of IVHM technologies for the thermal protection system (TPS). The objective of the Subsurface Microsensors for Assisted Recertification of Thermal Protection Systems (SmarTPS) project is to develop rapid and reliable inspection (health verification) technology applicable to both shuttle upgrades and to future reusable launch vehicles (RLVs). Technology will be developed to automate the detection of both surface and subsurface defects. Most surface defects can be detected from outside the vehicle using precision laser scanning technology. Subsurface defects, however, are difficult to detect without laborious hands-on inspections. For example, for the shuttle, every intertile gap is inspected visually, and TPS disassemblies are required to check for thermal degradation of bonding agents.

Development of an overtemperature microsensor and a noncontact inspection procedure to verify the health of the bond beneath intertile gaps was identified as the highest priority for health management of the TPS. A unified approach to accomplish both objectives is to wed wireless communications with microsensor development. To this end, the prototype microsensor shown in figure 1 was manufactured. The microsensor circuit contains a thermal fuse, a radio-frequency identification (RFID) microchip, a capacitor, and a coil antenna. The purpose of this microsensor is to indicate the occurrence of excessive temperature at the bond-line between the TPS and the structure of an RLV. The fuse opens at about 288 C, the multiple-use temperature limit of RTV-560, which is a common TPS bonding agent. The rest of the circuit is designed to return the microchip identification code, and a signal for whether or not the fuse is open, to a wireless radio-frequency transceiver such as depicted in figure 2. The microsensor is constructed from high-temperature components that should be able to withstand 10 to 15 minutes of exposure to 345 °C. The microsensor mass is below 0.1 gram; therefore, over 10,000 microsensors can be placed on an RLV at a total mass of under 1 kilogram.

Future plans include thermal, vibration, and other testing as required to qualify the microsensors for possible flight experiments on shuttle or X-vehicles. Microsensors incorporating fuses with different overtemperature limits may be manufactured, depending on the specific requirements of such experiments.

Point of Contact: F. Milos
(650) 604-5636
fmilos@mail.arc.nasa.gov

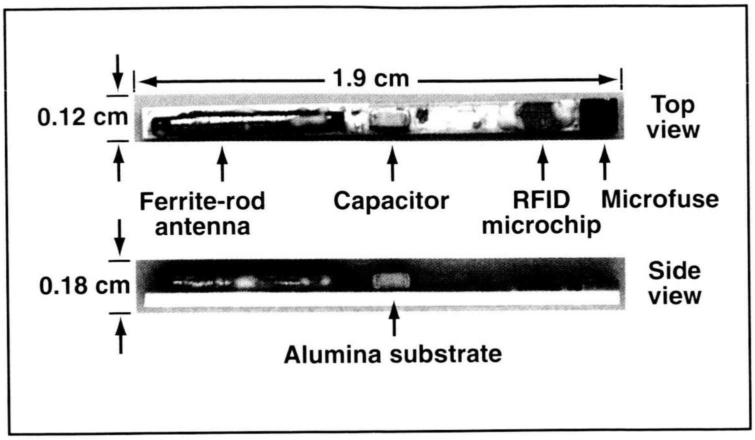

Fig. 1. Microsensor for excessive subsurface temperature.

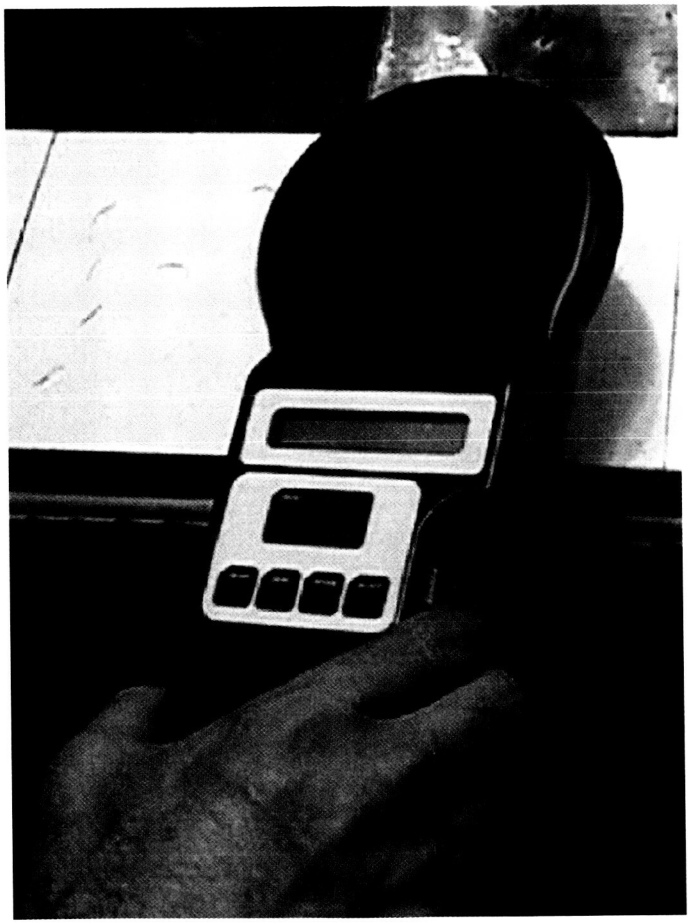

Fig. 2. Handheld radio-frequency transceiver.